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DRAWINGS ATTACHED

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(54) METHOD AND APPARATUS FOR FORMING GROOVES IN WORKPIECES

(71) We, GLAENZER SPICER, a body corporate organised under the Laws of France, of 10, Rue Jean-Pierre Timbaud Poissy (Yvelines), France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of forming grooves in workpieces, e.g. metal parts and to apparatus for carrying out this method.

It is standard practice to produce grooves in workpieces by cutting, rolling, drawing, or other methods requiring special machines, the cost of which are high.

It is likewise known to produce grooves by means of independent multiple tools, each of which produce a single groove and which are pushed by various means towards the workpiece to be grooved.

The present invention seeks to provide a method of making grooves of widely varying profiles in workpieces by means of apparatus which is extremely simple and consequently inexpensive.

Quite apart from the moderate cost of the apparatus used, by the method of the invention, the grooves are formed on the workpiece at a speed which cannot be achieved by conventional methods, so that the cost of labour is considerably reduced.

According to the present invention, we provide a method for forming grooves in a workpiece, comprising the steps of locating the workpiece within at least three jaws each of which has an operative surface presenting the configuration of the grooves required in the workpiece, two of said jaws being slidably mounted in a block provided with coacting guide surfaces, applying a force towards the centre of the workpiece to one or more of the other jaws to force the said two jaws against the guide surfaces on said block the inclination of said guide surfaces being so arranged that all of said jaws will be moved towards the centre of the workpiece and deform the surface of the workpiece in accordance with the contours of the operative surface of the jaws.

The workpiece which is to receive the grooves should have sufficient plasticity and should be brought to the diameter corresponding to the shaping jaws in the vicinity where the grooves are to be formed.

After the grooves have been formed, the part may be hardened, for example by surface hardening, by cementation or carbonnitriding followed by tempering, or by full hardening, or by any other known means.

The grooves may be disposed in any manner and have profiles of widely varying shapes.

The axis of the grooves may be parallel to that of the workpiece or the grooves may wind helically around the workpiece with any desired pitch.

The helical grooves may be shaped so as to form lozenge-shaped knurling.

The grooves may be intersected by one or more annular grooves.

The junction lines between the various jaws should as far as possible coincide with the bottom of a groove hollow or with an apex of a rib between grooves.

Burrs which would normally result from the formation of the grooves may if necessary be eliminated by forming flats on the portions of the workpiece corresponding to the junction lines of the jaws, before the grooves are formed.

The profiles of the grooves may vary along their axes and they may be disposed at equal or variable radial distances from the axis of the workpiece, so as to form a uniform or an inclined groove or a groove of olive-shaped profile, for example,

Further according to the invention we provide an apparatus comprising at least one

block provided with a pair of inclined planar guide surfaces defining, in cross section, a V-shaped channel in the block, at least three jaws for simultaneously gripping the workpiece intended to receive the grooves, each jaw having a grooved and/or ribbed operative face adapted to bear against the workpiece and a guide surface remote from the operative face, two of said guide surfaces being arranged to co-operate, one with each of the inclined guide surfaces on the block whereby the respective jaws will be constrained to move towards the centre of the workpiece and means for applying a pressure force to a jaw not constrained by said block, said means operating in conjunction with said block to force all said jaws against the workpiece to deform the surface of the workpiece to conform with that of the jaws.

In one construction, the apparatus comprises three jaws provided on their operative faces with one or more master grooves and/or ribs, said faces being adapted to adjoin one another in use so as to form a circular sequence of grooves and/or ribs having the same centre as said circumference, each of the jaws having a section of generally hexagonal shape in which the two sides situated on each side of the operative face, which is concave and on which the master groove(s) and/or ribs is/are provided are radially orientated in relation to said centre, the opposite side to the concave side being flat and arranged to come into contact either with an intermediate element fixed on a ram of a press for providing said pressure force, or with the inclined guide surfaces on the block to direct each jaw radially towards said centre.

In an alternative construction, the apparatus comprises four jaws provided on their operative faces with one or more master grooves and/or ribs, said faces being adapted to adjoin one another in use so as to form a circular sequence of grooves and/or ribs having the same centre as said circumference, each of the jaws having a section of generally hexagonal shape in which the two sides situated on each side of the operative face, which is concave, and on which the master groove(s) and/or rib(s) is/are provided are radially orientated in relation to said centre and normal to each other, the opposite side being flat, and in which two guide blocks are provided, each having a pair of inclined guide surfaces defining a channel of V-shaped cross section, said pressure force being arranged to move said guide blocks towards each other with the flat surfaces of the jaws in contact with a respective guide surface, whereby said jaws are brought into enclosing relationship around the workpiece to form the grooves on its surface.

Examples of the present invention are now described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows in section apparatus having three jaws provided with master grooves and intended to groove a cylindrical shaft;

Figure 2 shows the apparatus after formation of the grooves on said shaft;

Figure 3 shows in section apparatus having four jaws, after formation of the grooves on a shaft;

Figures 4 and 5 illustrate grooves formed respectively at the end of a shaft and on an intermediate portion of another shaft;

Figure 6 shows grooves formed on the conical end of a shaft;

Figure 7 shows a shaft on which there are formed grooves having concave hollows and convex edges;

Figures 8 to 11 illustrate cross-sections of parts on which grooves of different profiles have been formed.

The apparatus for carrying out the method may have three or four jaws.

Referring to the drawings, Figure 1 illustrates a first form of construction of apparatus comprising only three jaws 1, 2, and 3, each of which is provided with master grooves 1*a*, 2*a*, and 3*a*. In this case the top jaw 1 can receive direct the thrust of a ram, which moves in the direction of the arrow *f* to apply pressure or thrust on the top face 1*b* of the jaw.

During this thrust, however, the jaws 2 and 3 must slide on guide slopes 4 and 5 provided on two blocks, or preferably in a single block 6 having a V-shaped opening and fixed on a press table.

The sides of each of the jaws on each side of the grooves 1*a*, 2*a*, and 3*a* must be situated in radial planes passing through the axis 0 of the part to be machined.

Figure 2 illustrates a workpiece 7 and the apparatus at the end of the operation of forming the grooves.

Figure 3 illustrates apparatus comprising four jaws 8, 9, 10, and 11. In this case, two guide blocks 12 and 13 are required, and the faces of the jaws opposite the grooves in the jaws slide on guide slopes 14, 15, and 16, 17 which define V-shaped channels in said blocks, in order to reach the position around the workpiece 18 shown in Figure 3.

Grooves of many different types can be obtained by the method described above.

The grooves may be formed at the end of a shaft 19 (Figure 4) or at a particular intermediate part of a shaft, as illustrated in Figure 5. Grooves can easily be formed at the end or at the middle of a workpiece of very great length, because the axis of the workpiece is disposed perpendicularly to the plane of the ram of the press at the moment of the shaping.

Because of the process described above, it is not necessary to make a relief cut on each

side of the grooves formed in the middle of a shaft, and thus there is no weakening of the latter, as would result if a conventional method was used.

The grooves may be of variable profile along their axis. For example, their radial distance from the axis of the workpiece may be varied in order to obtain a conical shape of the end of a shaft 21 (Figure 6), or to obtain grooves 22, the apices of which have an olive-shaped profile as illustrated in Figure 7, i.e. there is a gradual increase of the diameter of the grooves to half-way along their length, followed by a likewise gradual decrease of the diameter.

The slightly conical or inclined grooves which are illustrated in Figure 6, and the smallest diameter of which is situated at the end of the shaft 21, or else cylindrical grooves slightly rounded at the end of the shaft permit axially forced driving into bores of solid parts of moderate hardness by a known process. The inevitable slight angular irregularities resulting from the process of the invention do not in any way prejudice the strength of the connection thus provided.

In this particular use of grooved parts, even if some slightly irregularities in the pitch of the grooves should occur during the forming of the grooves, the resulting connection will in fact appear good and will be strong, because the grooves are inserted into a bore in the part receiving it.

These small irregularities are naturally of no importance when the grooved part is to be sealed in a moulded material, because the grooves have the sole object of preventing the rotation of the part in said material.

Figure 8 illustrates in section a shaft 23 having only grooves distributed over two arcs of 90° symmetrically opposite one another.

Figure 9 shows in section a shaft 24 on which widely spaced grooves have been formed.

Figure 10 illustrates in section a shaft 25 provided with splines formed by arcuate grooves.

In all the above examples, the grooves are directed parallel or inclined in relation to the axis of the workpiece on which they are to be formed, but annular grooves may be made in a similar manner in planes perpendicular to said axis, so as to form a series of annular grooves.

The burrs resulting from the forming of grooves on a shaft 26 (Figure 11) or other similar part may be eliminated, if this is considered necessary, by forming flats 27 on the shaft prior to the formation of the grooves. In this case, after the grooves have been formed, the shaft will have the diagrammatical shape shown in that Figure.

In the above description, the jaws have been described as being provided with grooves. Naturally, if two grooves are provided on a jaw, they will be separated by a rib, and the workpiece will accordingly be formed with one groove and two ribs. Hence, in the extreme case, if one groove is required on the workpiece, only one rib will be provided on one of the jaws.

WHAT WE CLAIM IS:—

1. A method for forming grooves in a workpiece, comprising the steps of locating the workpiece within at least three jaws each of which has an operative surface presenting the configuration of the grooves required in the workpiece, two or said jaws being slidably mounted in a block provided with coacting guide surfaces, applying a force towards the centre of the workpiece to one or more of the other jaws to force the said two jaws against the guide surfaces on said block the inclination of said guide surfaces being so arranged that all of said jaws will be moved towards the centre of the workpiece in accordance with the contours of the operative surface of the jaws.

2. A method according to Claim 1, in which the workpiece is hardened after the grooves have been formed.

3. A method according to Claim 1 or 2, in which the workpiece is first formed with flats in the region where a junction between two jaws occurs to prevent burrs from being formed on the workpiece.

4. Apparatus for forming grooves in a workpiece comprising at least one block provided with a pair of inclined planar guide surfaces defining, in cross section, a V-shaped channel in the block, at least three jaws for simultaneously gripping the workpiece intended to receive the grooves, each jaw having a grooved and/or ribbed operative face adapted to bear against the workpiece and a guide surface remote from the operative face, and two of said guide surfaces being arranged to co-operate, one with each of the inclined guide surfaces on the block whereby the respective jaws will be constrained to move towards the centre of the workpiece and means for applying a pressure force to a jaw not constrained by said block, said means operating in conjunction with said block to force all said jaws against the workpiece to deform the surface of the workpiece to conform with that of the jaws.

5. Apparatus for forming grooves in a workpiece, as claimed in Claim 4, comprising three jaws provided on their operative faces with one or more master grooves and/or ribs, said faces being adapted to adjoin one another in use so as to form a circular sequence of grooves and/or ribs having the same centre as said circumference, each of the jaws having a section of

generally hexagonal shape in which the two sides situated on each side of the operative face, which is concave and on which the master groove(s) and/or rib(s) is/are provided are radially orientated in relation to said centre, the opposite side to the concave side being flat and arranged to come into contact either with an intermediate element fixed on a ram of a press for providing said pressure force, or with the inclined guide surfaces on the block to direct each jaw radially towards said centre.

6. Apparatus according to Claim 4, comprising four jaws provided on their operative faces with one or more master grooves and/or ribs, said faces being adapted to adjoin one another in use so as to form a circular sequence of grooves and/or ribs having the same centre as said circumference, each of the jaws having a section of generally hexagonal shape in which the two sides situated on each side of the operative face, which is concave, and on which the master groove(s) and/or rib(s) is/are provided are radially orientated in relation to said centre and normal to each other, the opposite side being flat, and in which two blocks are provided, each having a pair of inclined guide surfaces defining a channel of V-shaped cross section, said pressure force being arranged to move said guide blocks towards each other with the flat surfaces of the jaws in contact with a respective guide surface, whereby said jaws are brought into enclosing relationship around the workpiece to form the grooves on its surface.

7. Apparatus according to any one of Claims 4—6, in which the groove(s) and/or rib(s) on the jaws extend parallel to the workpiece axis and is/are intersected at right angles by one or more circumferential grooves.

8. Apparatus according to any one of Claims 4—7, in which the junction lines between adjacent jaws coincide either with the bottom of a groove hollow or with an apex of a groove.

9. Apparatus according to any one of Claims 4—8, in which the grooves and/or ribs are of constant profile along their axis.

10. Apparatus according to any one of Claims 4—8, in which the groove(s) and/or rib(s) has or have a profile which is variable along its/their axis and is/are disposed at equal variable radial distances from the axis of the workpiece, so as to form a conical groove or a groove of olive-shaped profile.

11. Apparatus for forming grooves in a workpiece substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

12. Apparatus for forming grooves in a workpiece substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

13. A method of forming grooves in a workpiece substantially as hereinbefore described with reference to Figures 1 and 2 or Figure 3, in combination with any of the other Figures of the accompanying drawings.

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1224419 COMPLETE SPECIFICATION
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Sheet 1

FIG. 1

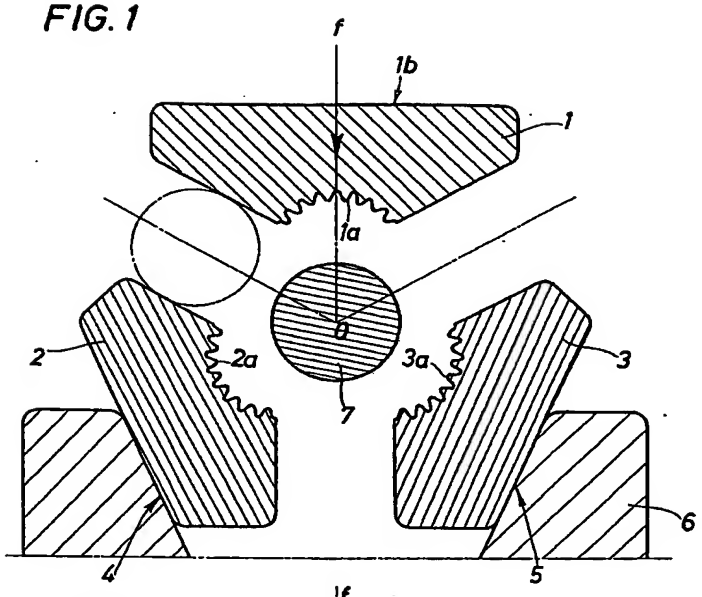
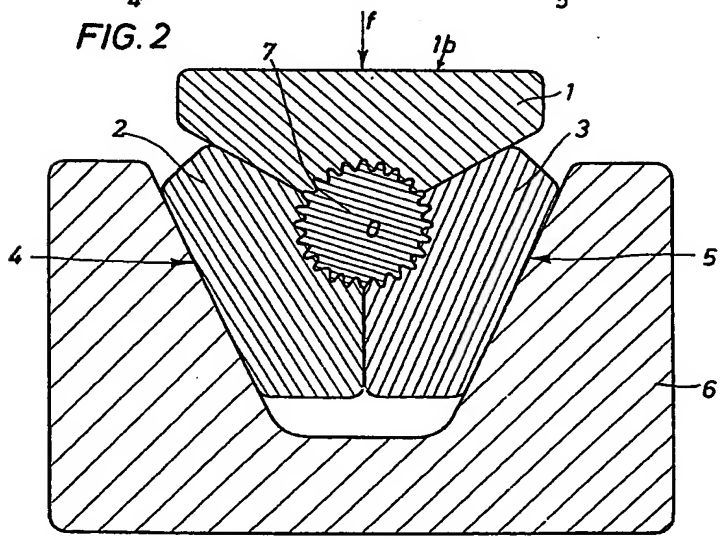


FIG. 2



1224419 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG.3

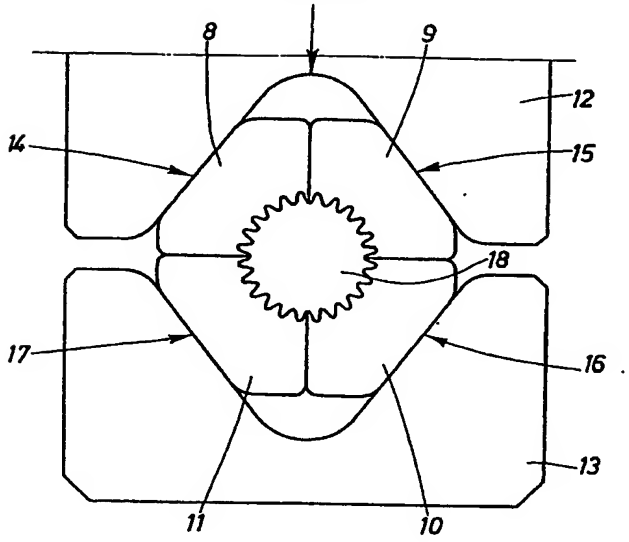


FIG.4

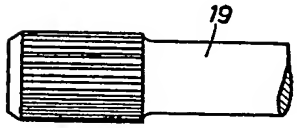


FIG.5

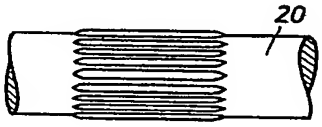


FIG. 6

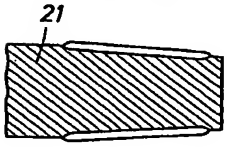


FIG. 8

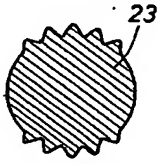


FIG.9

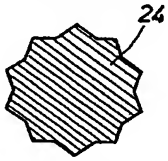


FIG.7

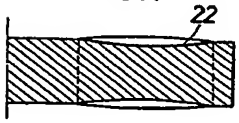


FIG.11

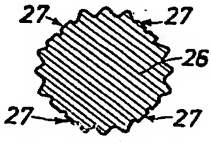


FIG.10